# PHOSPHATIZED OSTRACODS WITH APPENDAGES FROM THE LOWER CRETACEOUS OF BRAZIL

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ABSTRACT. A new ostracod, *Pattersoncypris micropapillosa* gen. et sp. nov., is described from the Aptian to Albian Santana Formation, Serra do Araripe, Ceará, Brazil. Of the 253 specimens obtained, 138 are complete carapaces of which 103 contain appendages in an excellent state of preservation. Of the total number of specimens only 15 are pre-adult instars and 6 are males. A small number (24) of single valves possibly represent moulted carapaces, the remainder were living up to the time of burial and fossilization. The original calcium carbonate and chitin of the ostracod was replaced by apatite immediately after death. The ostracods were found entombed with a teleost fish, *Cladocyclus gardneri* Agassiz, the decaying body of which, on which the ostracods are considered to have been feeding, is considered to have been the source of the phosphate salts responsible for the mineralization of the ostracod anatomy.

THE Santana Formation of Serra do Araripe, Ceará, northern Brazil, is a gypsiferous marl succession dated as ranging from the Upper Aptian to the Lower Albian (Beurlen, 1970). Fish-bearing nodules are particularly common in the marl beds and are collected and sold commercially for their well-preserved fish remains. Several such nodules have been prepared recently by Dr. Colin Patterson of the British Museum [Natural History], hereafter abbreviated (B.M.N.H.); the enclosed fish skeletons being etched from the nodule with acetic acid. In all previous preparations the calcareous ostracods present dissolved in the acid and were lost. In one nodule, however, examination of the washed residue revealed a number of well-preserved ostracods, complete with their appendages. A careful examination of further residues from the same nodule resulted in the recovery of 253 specimens consisting of whole carapaces and single valves of both adult and juvenile instars. In addition, many hundreds of eggs were recovered (Pl. 67, fig. 8) which may belong to this ostracod although they are small compared to the eggs of comparable living forms. In transmitted light the eggs appear completely transparent, with what was probably the yolk sac now apparently replaced by calcium carbonate.

The ostracods all belong to the same species and are clearly resistant to the acetic acid. An X-ray powder analysis of the carapace and of the body and appendages, by Dr. R. Davies (B.M.N.H.), revealed that both are preserved as apatite. Some carapaces still retain a calcium carbonate infilling but none of this material appears in the carapace itself.

Of the 138 complete carapaces, 103 retain appendages, many in an excellent state of preservation, and all represent individuals living up to the time of burial and mineralization. The remainder, together with the 24 single valves, probably represent moulted instars. Although an almost complete instar range has been obtained for *Pattersoncypris micropapillosa* only 15 pre-adult instars have been found; the remainder being adults falling into the final instar cluster as illustrated in text-fig. 1. Of the adult instars, only 6 have been identified as being males.

Although this discovery represents the best-preserved fossil ostracod material ever found, it is not the first record of fossil appendages. Brongniart (1876) was the first to

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record these in his *Palaeocypris edwardsii* from the Carboniferous of Saint-Étienne, whilst Sylvester-Bradley (1941) records the presence of appendages in Pleistocene specimens of *Cypris pubera* O. F. Müller. Subsequently, Gocht and Goerlich (1957) obtained chitinous appendages from some Jurassic and Cretaceous ostracods by dissolving complete carapaces in dilute hydrochloric acid. Gramann (1962) similarly observed chitinous antennae and antennules in the Liassic *Bairdia molesta* Apostolescu. More recently, Schmidt and Sellmann (1966) and Eagar (1970) have described mummified ostracods from the Pleistocene of Alaska and New Zealand respectively. Sohn (personal communication), however, is of the opinion that Eagar's find is a fresh-water mite and not an ostracod. None of these previous records attains the excellent state of preservation of *Pattersoncypris micropapillosa.*

The only previous records of ostracods from the Santana Formation appear in Santos and Valença (1968), where *Candonopsis* sp. and *Schuleridea* sp. were recognized, and more recently in Krömmelbein and Weber (1972), see p. 388. The occurrence of *Pattersoncypris micropapillosa* in the Santana Formation has been briefly recorded elsewhere (Bate, 1971).

The photographic illustrations for this paper were taken on a Cambridge Stereoscan scanning electron microscope whilst the text-figs. were drawn using a Leitz camera lucida.

All the specimens of *Pattersoncypris micropapillosa* are registered in the Collections of the Department of Palaeontology, British Museum [Natural History].

## SYSTEMATIC DESCRIPTION

Subclass OSTRACODA Latreille 1806
Order PODOCOPIDA Müller 1894
Suborder PODOCOPINA Sars 1866
Family CYPRIDIDAE Baird 1845
Subfamily CYPRIDINAE Baird 1845
Genus PATTERSONCYPRIS nov.

*Type species. Pattersoncypris micropapillosa* sp. nov.

*Derivation of name:* in honour of Dr. Colin Patterson.

*Diagnosis:* Cypridinae having oval carapace with acute antero-dorsal hump.

*Description:* Carapace ovoid in lateral view, convex in dorsal view. Greatest length of carapace passes through medial line. Shell surface without coarse ornamentation. Right valve with acutely projecting anterior cardinal angle and concave antero-dorsal slope. Hinge adont: groove situated in right valve, terminally expanded and accepting dorsal margin of left valve. Muscle scars as for family. First thoracic appendage adapted for feeding, with distal hook in both dimorphs. Antennules with 7 podomeres; antennae with 3 podomeres: first podomere with 6 swimming setae on inner face. Second and third thoracic appendages elongate, with 4 and 3 podomeres respectively. Furcae long. Paired hemipenes with broad, triangular proximal shield.

*Remarks. Pattersoncypris* is a typical member of the Cyprididae, having the muscle scars, carapace detail, and appendages of that family. Although without the marginal spines

of the Recent *Cypris pubera* O. F. Müller, there is a close similarity between the two genera with respect to the strong dorsal hump in the region of the anterior cardinal angle. The dorsal hump in *Pattersoncypris* is, however, a development of the anterior part of the hinge separate from the cardinal angle, and this, together with the more generally ovoid carapace outline serves to distinguish it from the genus *Cypris*.

The only fossil genus which approaches *Pattersoncypris* in carapace outline is *Brasacypris* Krömmelbein (1965*a*), described from the (?) Upper Jurassic to lower Cretaceous Bahia Series of Brazil. This genus, represented by the single species *B. ovum* Krömmelbein, differs from *Pattersoncypris* in the angular development of the posterior cardinal angle thereby giving it a more quadrate outline in lateral view. The right valve is also noticeably smaller than the left whilst in *Pattersoncypris* the carapace is virtually equivalve.

The following are currently placed in *Pattersoncypris*:

*Pattersoncypris micropapillosa*—type species, Santana Formation, Serra do Araripe, Brazil.

*Hourcqia angulata salitrensis* Krömmelbein and Weber, 1792, Santana Formation, Pernambuco, Brazil = *Pattersoncypris angulata salitrensis* (K. and W.).

*Hourcqia angulata sinuata* Krömmelbein and Weber, 1972, Riachuelo beds, Alagôas, Brazil = *Pattersoncypris angulata sinuata* (K. and W.).

## *Pattersoncypris micropapillosa* sp. nov.

(Pls. 66–71, text-figs. 1–12)

*Derivation of name.* With reference to the small papillae which cover the shell.

*Geological horizon and locality.* Aptian/Albian, Santana Formation, Serra do Araripe, Ceará, northern Brazil and from Continental beds from Liberia, N.W. Africa. Material from Liberia is not, however, included in the description of the species.

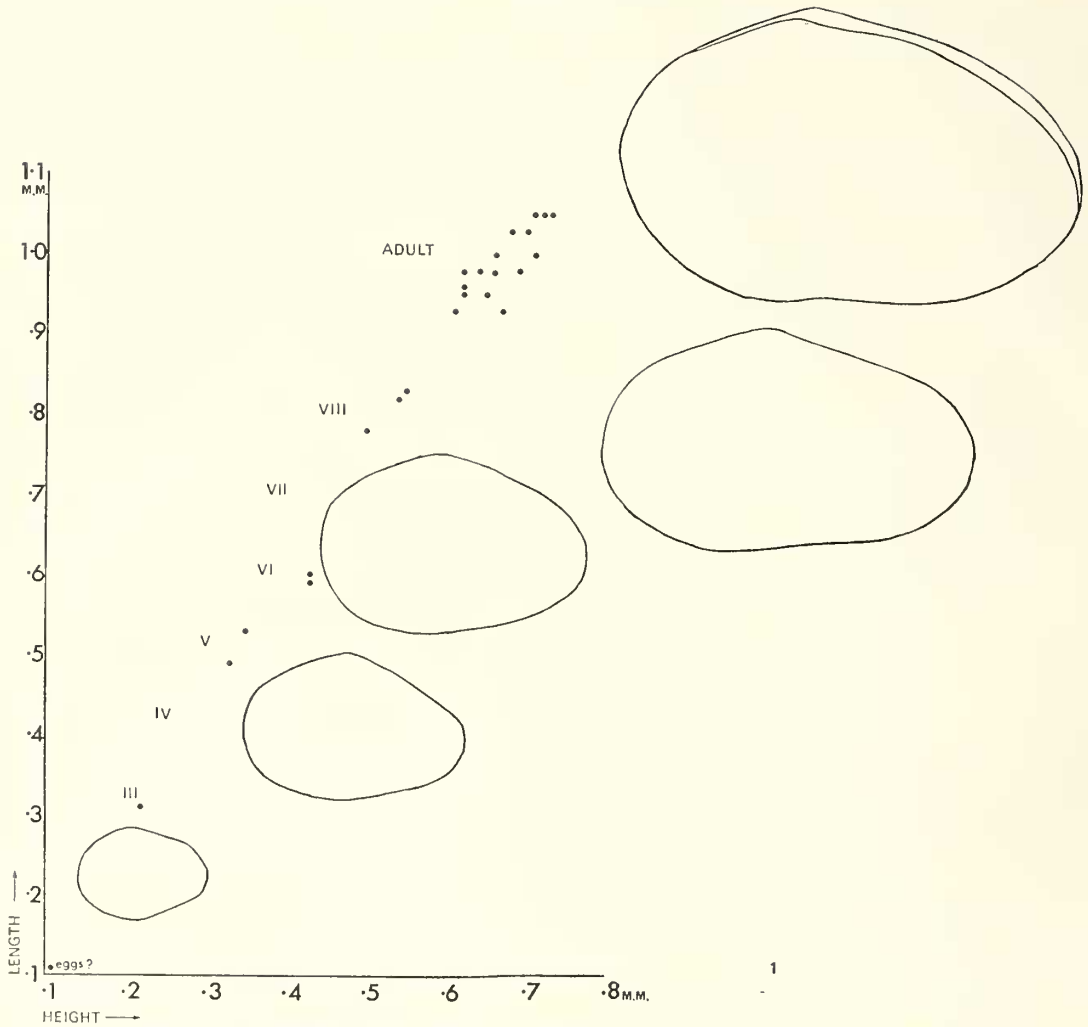
*Description.* Carapace oval in outline, virtually equivalve, with distinct antero-dorsal hump produced by the dorsal extension of the anterior hinge element, especially of the right valve (Pl. 66, fig. 1). Antero-dorsal slope of right valve concave; convex in the left valve. Anterior and posterior margins rounded. Instars III; V; VIII; and IX have been recognized and the length/height measurements plotted (text-fig. 1). A single clustering of individuals in the adult (IX) instar indicates that although both males and females are present the sexes are indistinguishable on carapace outline. The variable gape of the carapace in ventral view makes an accurate width measurement difficult. Eggs, which may through their association be regarded as belonging to this species despite their small size, have been plotted on text-fig. 1.

The shell surface is covered by very small papillae which are especially apparent on the ventral surface (Pl. 68, fig. 4).

Normal pore canals have sensory bristles projecting, although much shortened by breaking off at the tips, and are particularly well developed and more closely spaced in the anterior part of the carapace (Pl. 68, fig. 5).

The hinge is adont with the terminally expanded groove situated in the right valve (text-fig. 2). The left valve hinge is simply the dorsal edge of the valve (text-fig. 9).

Internally the selvage is set well back from the anterior free margin (text-fig. 2),




TEXT-FIG. 1. Size distribution of instars in *Pattersoncypris micropapillosa* sp. nov.

## EXPLANATION OF PLATE 66

Figs. 1–6. *Pattersoncypris micropapillosa* sp. nov. All figs. × 70. 1. External view, right side, female carapace, paratype Io. 4692. 2. External view, right side showing extended furcal rami, female carapace, paratype Io. 4693. 3. External view, left side, female carapace, paratype Io. 4704. 4. External view, left side, juvenile carapace, paratype Io. 4706. 5. External view, right side, juvenile carapace, paratype Io. 4702. 6. Dorsal view, female carapace, paratype Io. 4704.

## EXPLANATION OF PLATE 67

Figs. 1–5. *Pattersoncypris micropapillosa* sp. nov. 1. Appendage and body muscles, some attached to inside of carapace, showing typical mammillated crystal growth of apatite. Paratype Io. 4712 × 230. 2. Egg with small surface fracture. × 337. 3. Ventral view of female carapace to show extension of selvage over body of the animal. Female paratype, Io. 4698 × 70. 4. Ventral view, female carapace to show outer and inner lamella and appendages, holotype Io. 4680 × 70. 5. Enlarged view of oral region of holotype Io. 4680, to show basal podomere and endopodite of mandible, upper lip, maxillae, and proximal end, with setae, of first thoracic appendages. × 280.

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BATE, Phosphatized ostracods

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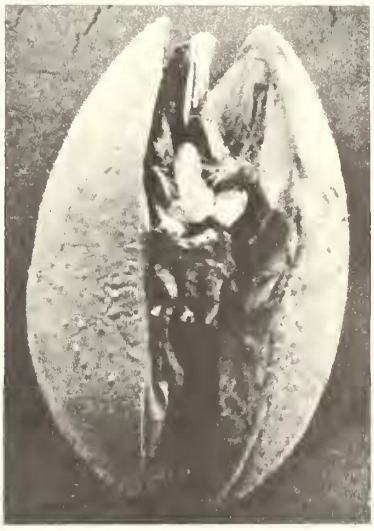

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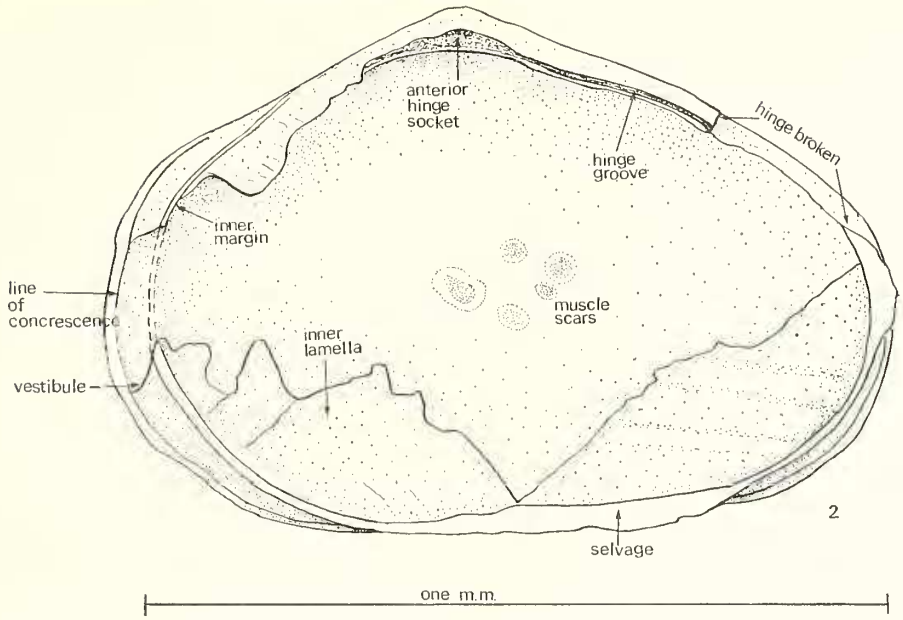
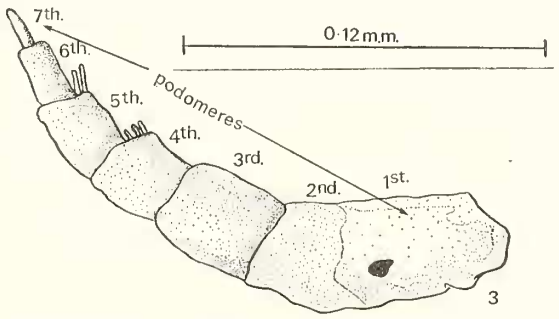
BATE, Phosphatized ostracods




TEXT-FIG. 2. Internal details, right valve paratype, Io. 4685.



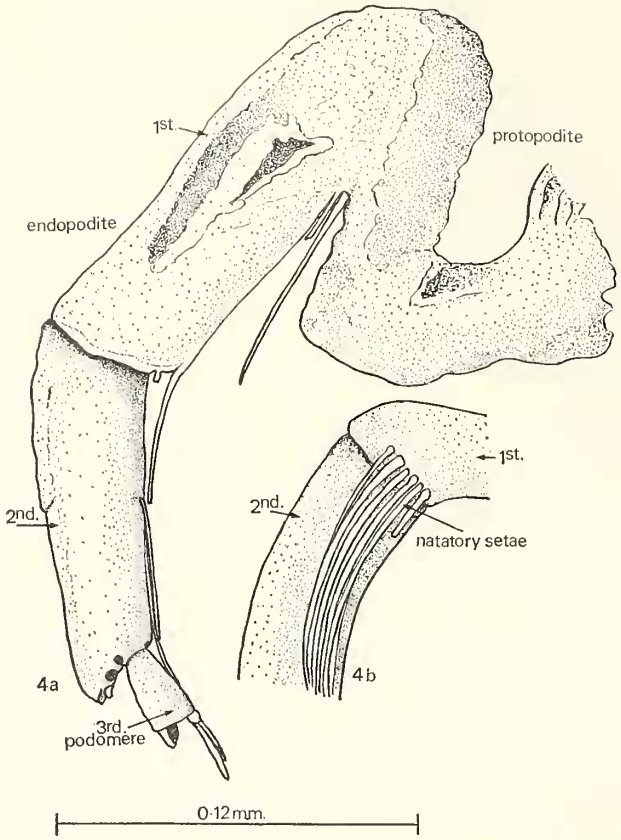

TEXT-FIG. 3. Left antennule, female paratype, Io. 4713.

whilst ventrally it develops into a prominent flap which covers the thorax when the valves are closed (text-fig. 2, Pl. 67, fig. 3).

The inner margin and line of concrescence do not coincide and a distinct vestibule, broader anteriorly, is developed along the valve margin. The line of concrescence is so close to the valve margin that there is no fused duplicature for the development of radial pore canals, which are not developed.

The muscle scars (Pl. 68, fig. 1) are typical of the family.

Antennules are long and possess seven elongate podomeres (text-fig. 3) as in the recent *Cypridopsis vidua* (Müller); but apart from those shown in Pl. 69, fig. 1, they are not sufficiently well preserved to show the setae. The length of the antennules suggests that they were used in swimming and that normally long, swimming setae would be present.




TEXT-FIG. 4. *a*, outside face, left antenna. *b*, inside face, right antenna to show natatory setae. Female paratype, Io. 4707.

The antennae are large and powerful (text-fig. 4*a*, *b*, Pl. 69, figs. 3, 4) and were useful in both swimming and crawling over the substratum. Six long, swimming setae, one of which has a feathered distal end, are situated on the inner face of the first of the three endopodite podomeres, whilst additional long setae, approximately 5 in number, are present at the distal end of the second podomere. Further setae are also present at the distal end of the smaller third podomere. The protopodite of the antenna appears to consist of two podomeres which may have fused to form a single segment, but this is difficult to determine and may be a product of fossilization.

The mandibles (text-fig. 5, Pl. 67, fig. 5) bear well-developed terminal teeth situated

EXPLANATION OF PLATE 68

Figs. 1–5. *Pattersoncypris micropapillosa* sp. nov. 1. Muscle scars, female carapace, paratype Io. 4693 ×282. 2. Internal view, left valve ×70 [specimen lost]. 3. Branchial plate of maxilla. Paratype Io. 4714 ×203. 4. Ventral view, female carapace to show papillose ventral surface and appendages. Paratype Io. 4709 ×238. 5. Bristle bases projecting through normal pore canal openings, anterior part of female carapace, paratype Io. 4721 ×2,380.

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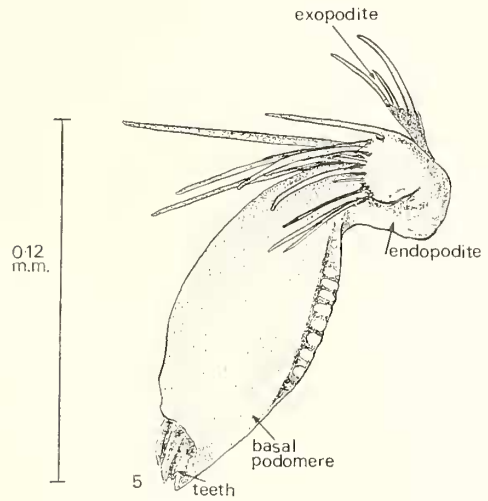
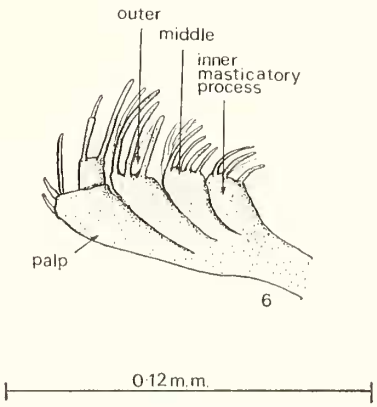
BATE, Phosphatized ostracods

at the distal end of the large basal podomere, the outer edge of which is serrated (text-fig. 5), the significance of the latter being uncertain. Long setae are present on both the endopodite and the exopodite, but the exact number has not been determined. The precise number of setae is generally not visible on other appendages but they are too brittle for dissection.

The maxillae (text-fig. 6, Pl. 67, fig. 5) consist of an outer palp and an outer, middle, and inner masticatory process. There appears to be a minimum of 5–6 setae on each process of the maxilla. The branchial plate has been observed only in a single specimen




TEXT-FIG. 5. Left mandible, female paratype, Io. 4680.




TEXT-FIG. 6. Right maxilla, female paratype, Io. 4720.

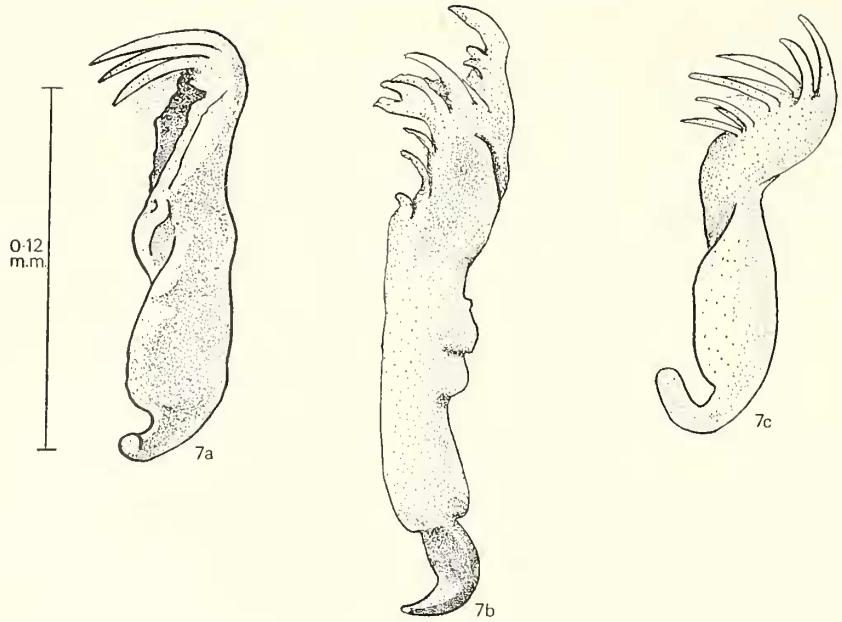
(Pl. 68, fig. 3) where it consists of a long, narrow arm and a paddle-shaped terminal blade bearing at least 10 short spines.

The upper lip is posteriorly a broad and triangular-shaped structure having a serrated edge on both sides of the centre point (Pl. 70, fig. 2). Anteriorly the upper lip becomes elongate and fuses with the forehead of the animal (Pl. 67, fig. 5).

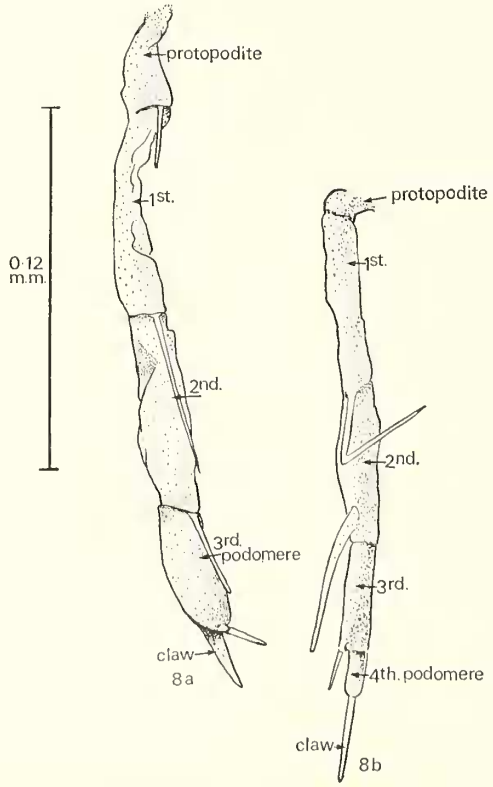
The first thoracic appendage is, as in other Cyprididae, adapted as a second maxilla used in feeding rather than for locomotion (text-figs. 7*a–c*, Pl. 70, fig. 1). Proximally there are approximately 13 setae used to propel food towards the mouth whilst distally the appendage terminates in a strong hook in both sexes. In the male, the first thoracic appendage is slightly longer than in the female.

The second thoracic appendage (text-fig. 8*b*) has four elongate endopodite podomeres, each of which has a distal seta. The seta of the fourth podomere, being the terminal spine or claw, has a strongly serrated or saw-toothed edge (Pl. 70, fig. 3).

The third thoracic appendage (text-fig. 8*a*) has three endopodite podomeres. The protopodite and the first and second podomeres of the endopodite possess a distal seta, whilst the third podomere of the endopodite terminates in a claw composed of 2 setae.



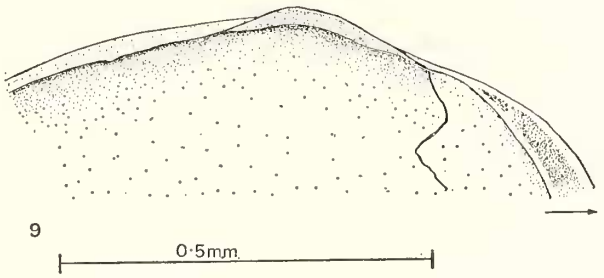

TEXT-FIG. 7. *a*, left first thoracic appendage, male? paratype, Io. 4719. *b*, left first thoracic appendage, male paratype, Io. 4682. *c*, left first thoracic appendage, female paratype, Io. 4681.



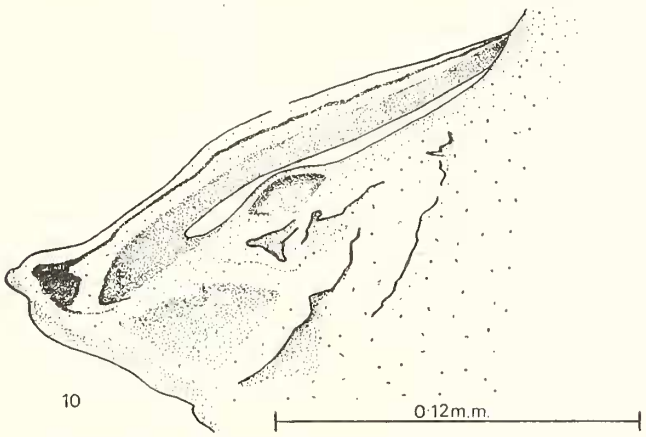

TEXT-FIG. 8. *a*, right third thoracic appendage, female paratype, Io. 4681. *b*, right second thoracic appendage, female paratype, Io. 4681.

The furca (text-fig. 10, Pl. 71, fig. 6) are long and appear to have simple rami, the extreme tip of which has either been broken off or is obscured. So far, however, there is no evidence of bifurcation.

The testes (Pl. 71, fig. 4) are coiled and situated postero-ventrally. The hemipenes (Pl. 71, figs. 1–5) are large, having a broad, triangular proximal shield, and in nearly every case project below the carapace due to the relaxation of the retaining musculature on the death of the animal.




TEXT-FIG. 9. Anterior hinge, left valve paratype, Io. 4684.




TEXT-FIG. 10. Furcal rami, female paratype, Io. 4715.

No eyes have been observed in this material although possibly present in the species. An eye has been included in the reconstruction of the ostracod in text-fig. 12.

| *Dimensions* (*in mm*) | | *length* | *height* | *width* |
|---|---|---|---|---|
| *Holotype*, | ♀ Io. 4680 | 0·93 | 0·67 | 0·61 |
| *Paratypes*, | ♀ Io. 4681 | 0·98 | 0·62 | 0·54 |
| | ♂ Io. 4682 | 0·95 | 0·65 | 0·58 |
| | ♀ Io. 4692 | 1·05 | 0·72 | 0·62 |
| | ♂ Io. 4696 | 0·98 | 0·64 | 0·58 |
| | ♀ Io. 4700 | 1·03 | 0·68 | 0·55 |
| | juv. R.V. Io. 4702 | 0·65 | 0·43 | |
| | juv. Io. 4705 | 0·49 | 0·33 | 0·27 |
| | juv. Io. 4706 | 0·64 | 0·43 | 0·36 |
| | R.V. Io. 4707 | 0·70 (broken) | 0·54 | |
| | ♂ Io. 4710 | 1·03 | 0·68 | 0·61 |